CLAIMS

1. A method for making paper/paperboard, comprising the following steps:

(a) formulating a first mathematical model of fracture toughness of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard;

(b) determining a desired fracture toughness value;

(c) determining respective values for each of said plurality of variables which, when inserted in said first mathematical model, result in a fracture toughness value approximately equal to said desired fracture toughness value; and

(d) manufacturing a paper/paperboard product having respective material properties represented by respective values that are substantially equal to said determined respective values.

2. The method as recited in claim 1, wherein one of said plurality of variables represents filler level.

3. The method as recited in claim 1, wherein one of said plurality of variables represents softwood pulp content.

4. The method as recited in claim 1, wherein one of said plurality of variables represents caliper.

5. The method as recited in claim 1, wherein said first mathematical model of fracture toughness is of the form:

$$FT = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

where x_1 is a function of filler level, x_2 is a function of softwood pulp content, z_2 is a function of caliper, and β_0 through β_3 are constants.

6. The method as recited in claim 1, further comprising the steps of:

(e) formulating a second mathematical model of stiffness of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard; and

(f) determining a stiffness value by inserting values for said variables in said second mathematical model, wherein two of said values were determined in step (c).

7. The method as recited in claim 6, wherein said variables used in said second mathematical model represent filler level, basis weight and caliper.

8. The method as recited in claim 1, further comprising the steps of:

(e) formulating a second mathematical model of internal bond of paper/paperboard as a function of a plurality of variables, each variable representing a respective material property of the paper/paperboard; and

(f) determining an internal bond value by inserting values for said variables in said second mathematical model, wherein one of said values was determined in step (c).

9. The method as recited in claim 8, wherein said variables used in said second mathematical model represent filler level, basis weight and relative humidity.

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10. A method for manufacturing paper/paperboard, comprising the following steps:

(a) manufacturing paper/paperboard product of a particular grade having a first set of respective values for a plurality of material properties that affect fracture toughness;

(b) measuring the fracture toughness of said paper/paperboard product;

(c) determining that the measured fracture toughness of said paper/paperboard product is different than a desired fracture toughness;

(d) determining a second set of respective values for said plurality of material properties that will produce a fracture toughness closer to said desired fracture toughness than was said measured fracture toughness; and

(e) manufacturing paper/paperboard product of said particular grade having respective values for said plurality of material properties that are respectively substantially equal to said ~~first~~ second set of respective values.

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11. The method as recited in claim 10, wherein said measuring step comprising determining the essential work of fracture.

12. The method as recited in claim 11, wherein one of said plurality of material properties is filler level.

13. The method as recited in claim 11, wherein one of said plurality of material properties is softwood pulp content.

14. The method as recited in claim 11, wherein one of said plurality of material properties is caliper.

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15. The method as recited in claim 11, wherein said step of determining a second set of respective values for said group of material properties is performed using a mathematical model of fracture toughness as a function of said plurality of material properties.

16. The method as recited in claim 15, wherein said mathematical model of fracture toughness is of the form:

$$FT = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

where x_1 is a function of filler level, x_2 is a function of softwood pulp content, z_2 is a function of caliper, and β_0 through β_3 are constants.

17. A method for operating a paper mill, comprising the following steps:

manufacturing different grades of paper or paperboard;

measuring the fracture toughness of test samples of paper or paperboard taken from multiple production runs;

for each of a multiplicity of production runs, storing fracture toughness measurements and associated material property data in a databank;

retrieving from said databank a set of material property data for a grade of paper or paperboard; and

manufacturing a grade of paper or paperboard product having material properties that are respectively substantially equal to values in said material property data retrieved from said databank.

18. The method as recited in claim 17, wherein each set of material property data comprises respective

data for caliper, softwood pulp content and filler level of a respective grade of paper or paperboard.

19. A method for designing a grade of paper or paperboard, comprising the following steps:

performing a factorial experiment to investigate the effects of papermaking variables on in-plane fracture toughness of a grade of paper or paperboard;

analyzing data acquired by said factorial experiment to derive a statistically significant mathematical model for fracture toughness as a function of a plurality of material properties of said grade of paper or paperboard.

20. The method as recited in claim 19, further comprising the steps of selecting a desired fracture toughness for a grade of paper or paperboard to be manufactured and determining values for said plurality of material properties which, when input to said mathematical model, produce a calculated fracture toughness approximately equal to said desired fracture toughness.

21. The method as recited in claim 19, wherein said plurality of material properties comprise caliper, softwood pulp content and filler level.

22. The method as recited in claim 20, further comprising the steps of:

manufacturing a plurality of paper or paperboard products of a particular grade, each product having a different fracture toughness;

converting said products in a printing press;

acquiring data reflecting the press runnability performance of each of said products in said printing press; and

determining an optimal range of fracture toughness based on acquired press runnability performance data,

wherein said desired fracture toughness is selected from said optimal range of fracture toughness.

23. The method as recited in claim 20, further comprising the step of manufacturing a paper or paperboard product having the material properties that were input to said mathematical model.

24. The method as recited in claim 20, wherein said mathematical model of fracture toughness is of the form:

$$FT = \beta_0 - \beta_1 x_1 + \beta_2 x_2 + \beta_3 z_2$$

where x_1 is a function of filler level, x_2 is a function of softwood pulp content, z_2 is a function of caliper, and β_0 through β_3 are constants.